# WEATHER CONDITIONS FAVOURABLE TO THE INCREASED INCIDENCE OF INFLUENZA VIRUS IN SELECTED REGIONS OF POLAND

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**ABSTRACT. – Weather conditions favourable to the increased incidence of influenza virus in selected regions of Poland.** Human health is affected by a variety of factors. Weather conditions are hardly ever the direct cause of illness, but they may be among the top underlying factors. This paper discusses the variation of incidence of influenza and influenza-like illnesses in Poland depending on the weather conditions prevalent in the 2010/11-2013/14 seasons, as compared to incidence data since 1974. In particular, it focuses on extreme cases and areas of increased rates of said infections. Medical statistics and meteorological data from 16 Polish provinces were used as input to the study. The flu season was defined as the period starting in October and ending in April. All months in the selected seasons were analyzed, with particular attention paid to those which stood out among others due to the high number of cases recorded. Increased incidence of influenza and influenza-like illnesses was evident in periods with severe weather changes.

**Keywords:** influenza virus, flu season, biometeorology, Poland

## 1. INTRODUCTION

The processes occurring in the atmosphere exert constant influence on the human body, which is continuously adapting to the changing weather conditions. The human body works best within a certain optimum range of climatic conditions, i.e. weather conditions which approximate the average values typical of a particular season of the year and the latitude the person inhabits. Therefore, any extreme conditions disturb the psychosomatic equilibrium of the human body. Thus, weather shapes both mental and physical objective reactions, aggravating symptoms of chronic conditions and contributing to increased incidence of viral infections (Kuchcik, Błażejczyk 2001; Van Noort et al. 2012).

The influenza virus may potentially occur in all climate types and in all months of the year; however, in the moderate climate zone, the incidence of the illness is clearly seasonal (Silva et al. 2014). This seasonal pattern is determined by a variety of factors and has been extensively studied by scientists representing a range of disciplines (Shaman, Kohn 2009). However, it is clear that weather conditions favour increased incidence of influenza-like illnesses. Moreover, abrupt changes in the value of meteorological elements (especially air temperature and

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humidity) most often result in such increased influenza activity and sometimes even an epidemic.

Several seasons of increased incidence, referred to as flue pandemics, were recorded over the last century. One of the first outbreaks, whose consequences were clearly reflected by the high number of deaths all over the world, was the "Spanish flu". Ca. 500 million people, i.e. 1/3 of the global population, were infected during the epidemic. It is estimated that at least 40 million people died of the disease in 1918 and 1919, thus making its overall death toll several times higher than that of World War I (Taubenberger, Morens 2006).

At moderate latitudes, influenza infections typically spread most vigorously in autumn, early winter and during the advent of spring (Shoji et al. 2011). The most affected groups predominantly include children and the elderly (people aged over 65), as well as adults suffering from chronic diseases of the circulatory or the respiratory system, or people with immunologic disorders (Lee et al. 2014).

The aim of this study is to describe the variation of incidence of influenza and influenza-like illnesses in particular Polish provinces from the 2010/11 to the 2013/14 flu seasons. In particular, it focuses on extreme cases and areas with increased infection rates.

## 2. DATA AND METHODS

Medical statistics and meteorological data were used as input for the study of the impact of weather conditions on the incidence of influenza and influenza-like illnesses. Information on influenza incidence (average daily number of cases per 100,000 residents) in all Polish provinces comes from weekly epidemiologic reports of the National Public Health Institute – National Institute of Hygiene. Analyses of weather conditions were based on studies of the meteorological elements which, according to various authors, have a decisive impact on increased influenza incidence, i.e. mean, minimum and maximum daily air temperature, as well as mean daily relative air humidity (Shoji et al. 2011, Shaman et al. 2010). The selected elements are also most widely considered in bioclimatic analyses and often constitute components of biometeorological indices determining the impact of the weather on the human body.

A detailed analysis was performed focusing on the incidence of influenza in all 16 Polish provinces during four flu seasons. A flu season was defined as the period starting in October and ending in April. All months in the selected seasons were analysed, with particular attention paid to those which stood out among others due to the high number of cases recorded. Patients' age structure was also taken into account. The weeks with the highest incidence of influenza were correlated with particular weather elements measured at weather stations located in the capital cities of particular provinces.

## 3. RESULTS

An analysis of the number of cases of influenza infection since the mid-1970s shows very clear peaks and troughs (fig. 1). The greatest number of people contracted the illness in the early years of the aforementioned period (until 1980). This was most certainly caused by poorer healthcare standards and the lack of vaccines. It is also attested to by the extremely high number of influenza-related deaths in that period (Fig. 1).

The incidence of influenza in Central Europe follows a clearly seasonal pattern. On average, ca. 1-1.5 million people develop the illness between September and August. The season which clearly stands out in 21st century data is 2012/2013, with 3 million cases recorded in Poland (Fig. 2). An influenza epidemic on a similar scale had not been seen since 1995/96, i.e. for 17 years.

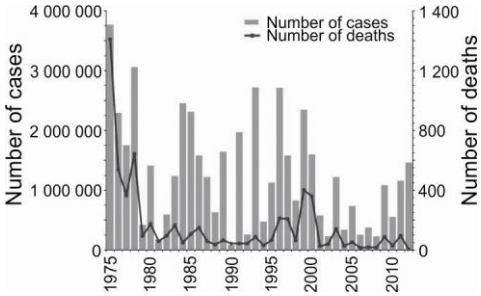


**Fig. 1.** ***Number of cases of influenza infection and number of deaths in Poland from 1975 to 2012 (Source: www.pzh.gov.pl)***

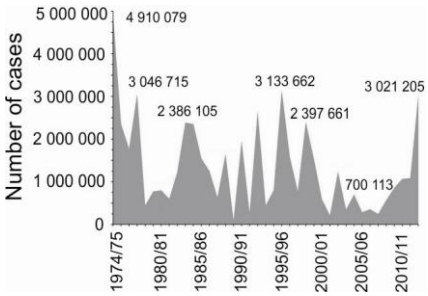


**Fig. 2.** ***Number of confirmed and suspected cases of influenza in the September-August season in Poland from 1974/5 to 2012/13 (Source: www.pzh.gov.pl)***

Figure 3 presents the average monthly influenza activity in the analysed seasons in Poland. The data presented here indicate that it is impossible to clearly state which month is characterised by the highest incidence. In the analysed seasons, the months with the highest number of cases were February 2011, March 2012, January 2013 and March 2014. However, it is clear that the 2012/13 season stands out among these top four periods. It was marked by a very high number of cases in January, with the mean daily incidence of 65 cases/100,000 population, and in February (43 cases/100,000 population) (Fig. 3).

Children aged under 4 were the most vulnerable group in all of the seasons under consideration (fig. 4). Mean daily incidence in this age group all over Poland in the 2013/14 season was 120 cases per 100,000 population, while in the preceding season it was 112/100,000 population and in the first two seasons - ca. 40 cases/100,000 population (Fig. 4).

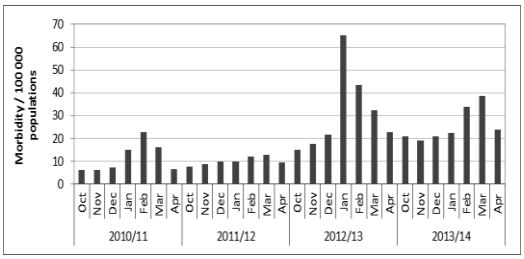


**Fig. 3.** ***Mean daily incidence of influenza in particular months in Poland in the 2010/11-2013/14 seasons***

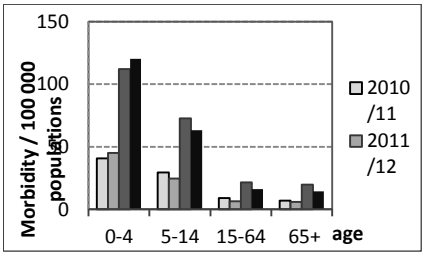


**Fig. 4.** ***Incidence of influenza by age group in particular seasons in Poland***

In the first two seasons, i.e. 2010/11 and 2011/12, most cases were recorded in the Masovia, Lesser Poland and Greater Poland Provinces – ca. 20 cases/100,000 population - and the fewest in the Lubuskie and Świętokrzyskie Provinces (0-3 cases/100,000 population) (Fig. 5). In the 2012/13 and 2013/14 seasons, most cases were recorded in the Pomerania Province (117 and 99 cases/ 100,000 population, respectively). Just as in previous seasons, the fewest cases were recorded in Lubuskie, Świętokrzyskie and West Pomerania Provinces (6-15 cases/100,000 population) (Fig. 5). As mentioned before, the greatest increase in influenza incidence occurred in January 2013 (117 cases/100,000 population in Poland). Mean daily incidence in this month all over Poland amounted to 65, while in the Pomerania Province it reached 182 cases/100,000 population. The following season (2013/14) also saw relatively high rates. The greatest number of cases was also recorded in the Pomerania Province at the time (98 cases/100,000 population) (Fig. 5).

The following part of the paper looks at the meteorological conditions prevailing in the seasons under consideration. Fig. 6 presents the mean monthly values of temperature and relative air humidity in Poland, averaged from 16 meteorological stations located in the capital of each Polish province. They clearly indicate that the first two seasons were marked by very diverse thermal conditions, especially in winter, when the number of influenza cases significantly increased: December 2010 (-5.4°C), February 2011 (-3.4°C) and 2012 (-5.8°C) were very cool, while January 2011 and 2012 (-0.5, -0.7°C) were moderately warm and December 2011 (8.7°C) was extremely warm (Fig. 6). Such significant temperature oscillations undoubtedly contributed to increased incidence of influenza. In the first two seasons, most people became ill in the months following the thaw period. In the winter of 2012/13 and 2013/4, temperature did not oscillate so significantly from month to month. It is also difficult to identify clear differences between particular seasons in terms of the course of mean monthly relative air humidity. Therefore, the following stage of the study focused on the daily values of selected meteorological elements at each weather station, as compared to the influenza incidence data. Specific attention was paid to weather in the Pomerania Province,

which had the highest number of reported cases, and in the Lubuskie Province, where the number was lowest.

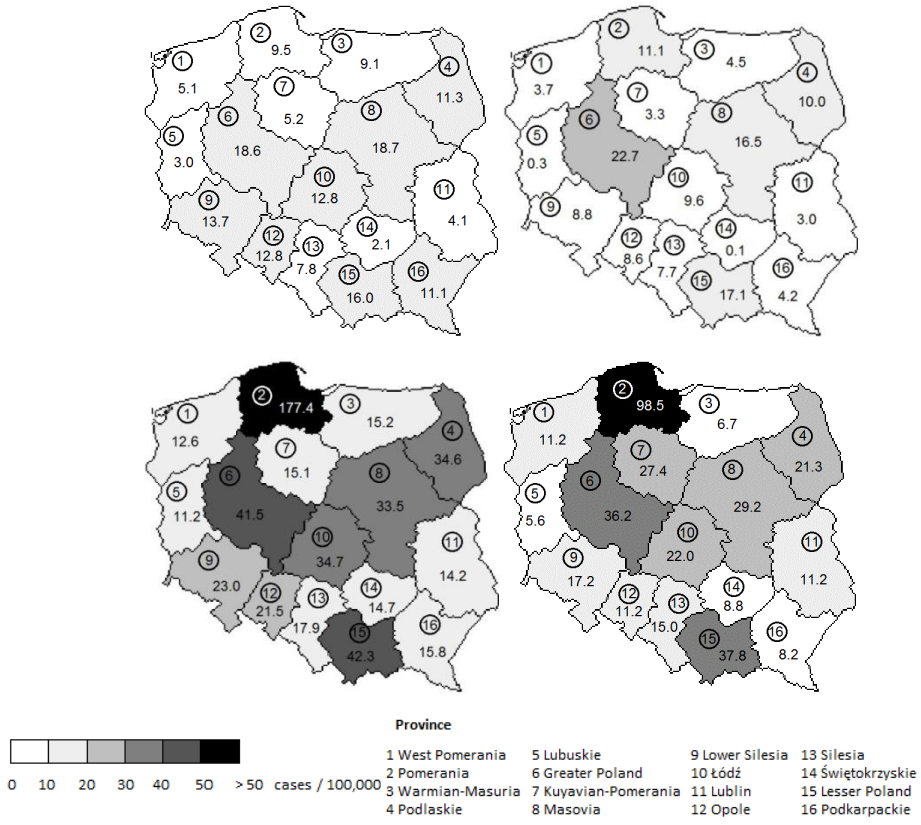


**Fig. 5.** ***Incidence of influenza in particular Polish provinces in particular seasons from 2010/11 to 2013/14***

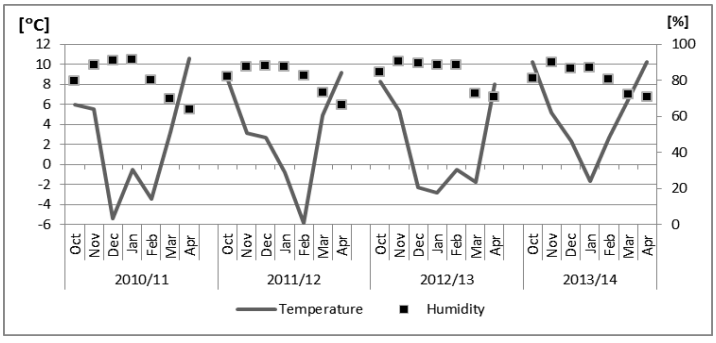


**Fig. 6.** ***Mean monthly air temperature and humidity in Poland in the 2010/11-2013/14 seasons***

The values of air temperature and the number of reported cases of influenza between December 2012 and March 2013 in Gdansk (Pomerania Province) and Zielona Góra (Lubuskie Province) (Fig. 7) again indicate that the spring thaw period with a higher than average air temperature is followed by its significant drop and an increase in the number of influenza cases. Daily incidence in Gdansk in this period amounted to 209 cases/100,000 population. Therefore, factors contributing to the spread of the disease include abrupt temperature changes over a short period of time, especially during humid overcast weather with strong gusty winds, rain or sleet.

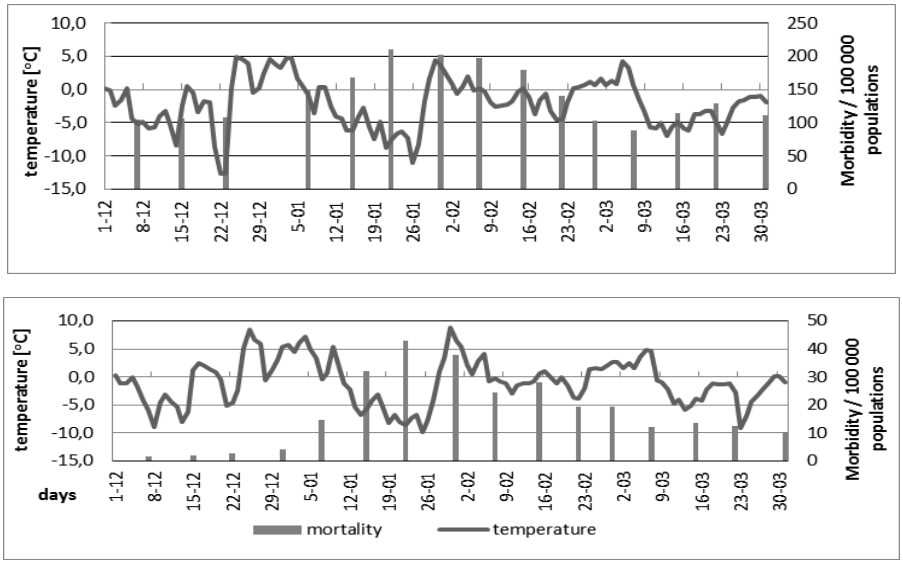


**Fig. 7.** ***The mean daily air temperature in Gdansk and Zielona Góra and the incidence of influenza in Pomerania and Lubuskie Provinces in the period from 1st of December to the 30th of March 2013***

In Gdansk, late January and early February 2013 (16 January-7 February) turned out to be the height of the influenza season (Fig. 7). During said three weeks, the mean daily incidence in the province amounted to 202 cases/100,000 population. Significant oscillations of particular meteorological elements were observed all through that period, but the week from 25 to 31 January 2013 was the most extreme one, with mean daily air temperature ranging from -11.1°C to 4.4°C, minimum temperature from -15.0 to 3.0°C and maximum temperature from -9.0 to 7.0°C (Fig. 7). Relative humidity oscillated within the range 78-95%. High wind speed values (up to 13.9 m/s), with gusts of up to 23.1 m/s on 31 January 2013, were also recorded in this period.

The Lubuskie Province turned out to be the area with the lowest incidence of influenza in Poland. In the town of Zielona Góra, the highest number of cases of

influenza in the 2013/14 season was recorded from 16 to 31 January, amounting to only 41/100,000 population. At the same time, particular meteorological elements also exhibited greater changes, although they were more limited than in Gdansk. Mean daily air temperature ranged from -9.9°C (25 January) to 8.8°C (30 January) (Fig. 7). During these five days, significant peaks and troughs were also observed in terms of the values of particular meteorological elements, such as minimum temperature (3.7–-13.0°C), maximum temperature (-6.0–12.0°C), relative humidity (72-95%) and wind, which was blowing at up to 10 m/s, gusting to even 18 m/s (Fig. 7).

Such high incidence of influenza and influenza-like diseases may probably be partially explained by the insufficient adaptation of the residents of the Pomerania Province to such abrupt weather changes.

## 4. CONCLUSIONS

Since the mid-1970s, most cases of influenza were recorded before 1980, which could be due to poorer healthcare standards at the time and lack of vaccines. This can also be attested to by the extremely high number of influenza-related deaths in that period. The incidence of influenza in Central Europe follows a clearly seasonal pattern. Most people become ill between October and April. An exceptional season in Poland in the 21st century was 2012/13, when more than 3 million inhabitants of the country are estimated to have developed the condition. In the aforementioned season in January the mean daily incidence amounted to 65 cases/100,000 population and in the Pomerania Province to as many as 182 cases/100,000 population.

Infants and children aged under 4 were always the most vulnerable group in all of the aforementioned seasons. The mean daily incidence in this age group all across Poland in 2013/14 amounted to 120 cases/100,000 population.

An analysis of the meteorological conditions clearly shows that in all of the analysed period, most cases of influenza occurred following the thaw season. It is clear that abrupt changes in temperature over a short period of time contribute to the spread of the disease.

In the Pomerania Province, which had the highest incidence in Poland, the period from late January to early February (16 January-7 February) saw the greatest flu activity. During these three weeks, the mean daily incidence in the province amounted to 202 cases /100,000. The entire period was characterised by significant oscillations of particular meteorological elements, but the week from 25 to 31 January 2013 was the most extreme period.

The Lubuskie Province experienced the most limited flu activity in Poland. In the town of Zielona Góra, the highest number of cases of influenza in the 2013/14 season was recorded from 16 to 31 January, amounting to only 41 cases/100,000 population. At the same time, particular meteorological elements also exhibited greater changes, although they were more limited than in Gdansk.

A comparison of data from two stations located in cities with contrasting influenza incidence shows that the oscillations of selected meteorological elements in Gdansk were much more significant. It can be stated with a high degree of probability that residents of the Pomerania Province, due to its location at the Baltic Sea, have more difficulty adapting to extreme weather conditions. Regardless of the season of the year, the climatic conditions prevailing in the area are milder, more typical of seaside zones.

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